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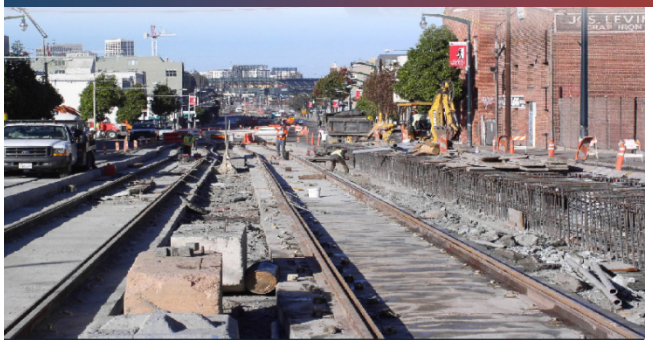
TPM/Office of Engineering

Geotechnical Risk Management Lessons Learned Discussion Panel

Washington DC, June 13th 2008



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Background

- Recapping this experience in Pittsburgh (PAAC NSC003/006 and NSC-004), Seattle (ST C710, Beacon Hill), Los Angeles (LACMTA, ESGL C800) and New York (NYCTMA's CM009, CM019) is that these projects taken as an aggregate, experience cost growth in terms of geotechnical scope, market risk and post award changes in the form of differing site conditions.
- This cost growth is typically in the range of
  - 45% (PAAC NSC-003/006, ST C710, LACMTA C800, NYCMTA CM009) to
  - 60% (PAAC NSC-004, NYCMTA CM019) of the engineer's estimate.

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(Preliminary) Lessons Learned

- The PMPs need to lay out a Geotechnical plan (GP) as the primary management subplan under the PMP and the parent document to all underlying geotechnical, environmental site, groundwater hydrology reports, etc.
- The GP should require data reports (GDRs,etc.), Interpretative reports such as GIRs, Geotechnical Contracts Risk Allocation Plan/Geotechnical Baseline Reports (GBRs)
- All interpretative reports such as the Geotechnical Interpretative Report (GIR), Groundwater Hydrology, Environmental site assessment, Etc. should be project level.
- All Geotechnical Design Memorandums (GDMs) should be integrated into the GIR. [GIR (Parent) and GDMs (Children)]
  - Especially in terms of design considerations and most importantly, their construction considerations.

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(Preliminary) Lessons Learned

- All interpretative reports such as the Geotechnical Interpretative Report (GIR), Groundwater Hydrology, Environmental site assessment, Etc. should contain construction considerations sections that address all material scope items.
  - Should be managed as a configuration process item and kept current with project configuration as it changes.
  - These construction considerations sections should be reviewed by project construction managers, estimators
  - Should also be subjected to periodic, formal constructability reviews.

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(Preliminary) Lessons Learned

- Geotechnical Contracts Risk Allocation Plan (GCRA) and Geotechnical Baseline Reports (GBRs)
- Allocate project level risk implied by the interpretative reports in a set of GBRs for the geotechnical packages.
- GBRs typically have 15 to 20 baseline elements.
- Rationales for setting values and range that they might change in a negotiated procurement, etc…

(Preliminary) Lessons Learned

- Project scope implied in interpretative reports such as the Geotechnical Interpretative Report (GIR), Groundwater Hydrology, Environmental site assessment, Etc. should "crosswalk" to project cost estimates and schedules.
  - PWBS to Contract Package WBS, or CWBS
  - Dynamic process

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(Preliminary) Lessons Learned

- Project scope implied in interpretative reports such as the Geotechnical Interpretative Report (GIR), Groundwater Hydrology, Environmental site assessment, Etc. should "crosswalk" to project cost estimates and schedules.
  - **Cost Estimate task structure and Interpretative reports have not been the same! Scope is being missed! Contractor Contingencies are not being estimated!**
  - PWBS to Contract Package WBS, or CWBS
  - Dynamic process

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Discussion

- Questions?

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Geotechnical Risk Management
Lessons Learned
Discussion Panel
Re-Look Issues and Lessons Learned

Washington DC, June 13th 2008

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Lessons Learned

- Movement toward contractor assuming risk
- Magnitude of Bid overages is attributed to market forces
- One bidder scenario erodes Grantee leverage
  - Changes negotiated in hostile environment – contractor sheds less favorable portions of contract (risk, expertise)
  - Contractor credits for work removed from scope are balanced against added scope estimates
  - Work scope moved to other contracts not estimated
- PMOC challenges in risk assessment re-look environment
  - Monitoring in-depth is limited in traditional oversight role
  - Specialists called in to take snap-shot of work
  - Disconnects occur as work scope changes during characterization
- Geotechnical Interpretive Reports used in place of baselines

Items for Discussion

- Management Structure
- Construction Management Plan
- Design Management
- Systems Manager/ Systems Integration
- Management tools for Force Account Work
- Project Partnering (case-by-case basis)

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Items for Discussion

- Schedule Contingency Management
- Risk Tolerance/Allocation Approach to Contracting
- Mitigate Potential Long Procurement Durations
- approach to sharing commodity escalation risk
- market risk mitigation strategy for possible limited competition contract packages
- identify real estate stakeholders who can force unwanted change onto project

Items for Discussion

- Provide work breakdown structure for the repackaged work
- rigorous approach to configuration management regarding scoping of remaining work to be bid
- document linking Geotechnical Plan with cost estimating process
- quantity take-off variances found by PMOC
- calculate the Contingency Drawdown

Recommendations

- Major Contract Re-Packaging must be taken into account when conducting Re-looks
  - Timing for analysis
  - Integration of information
- Integrate specialists into monitoring effort to streamline re-looks
- Integrate Risk Assessment Metrics into Monitoring Effort
- Use Target Based Strategies to Implement and Monitor Gap Mitigation

NYCMTA ESA
Mitigation Workshop (PG-40)

Grantee BCE vs. Thresholds

- The BCE was finalized at $6.349 bn to include additional costs for escalation
- Contingency was revised to $855mil
- Program milestones and probabilities were estimated using PG-40 (Level 1) models as follows:

		$6.349bn	$6.6bn	$6.8bn	$7.0bn	Target
20% bid 5% Construction	(Q4 2006)	15%	21%	27%	33%	30%
40% Bid 10% Construction	(Q4 2007)	24%	36%	46%	58%	60%
60% Bid 20% Construction	(Q4 2008)	37%	48%	61%	73%	70%
80% Bid 40% Construction	(Q4 2009)	49%	71%	84%	93%	75%
100% Bid/50% Construction**	(Q4 2010)	86%	98%			80%
100% Bid/75% Construction	(Q4 2011)	97%				85%
90% Construction	(Q2 2012)					90%
Start-up Phase	(Q4 2013)					95%

NYCMTA ESA Workshop
Threshold Probabilities versus Project Phase

"Triggered" Mitigation Requirements: $6.349bn BCE

- **Since BCE manage "gaps" between target and forecasts with contingency and "triggered" mitigation.**

	Target	Delta($)
20% bid/ 5% Con (Q4/06)	40%	$551mm
40% Bid/ 10% Con (Q4/07)	60%	$716mm
60% Bid/ 20% Con (Q4/08)	70%	$608mm
80% Bid/ 40% Con (Q4/09)	75%	$335mm
100% Bid/ 50% Con (Q4/10)	80%	negative
100% Bid/ 75% Con (Q4/11)	85%	negative
90% Construction (Q2/12)	90%	negative
Start Up…		

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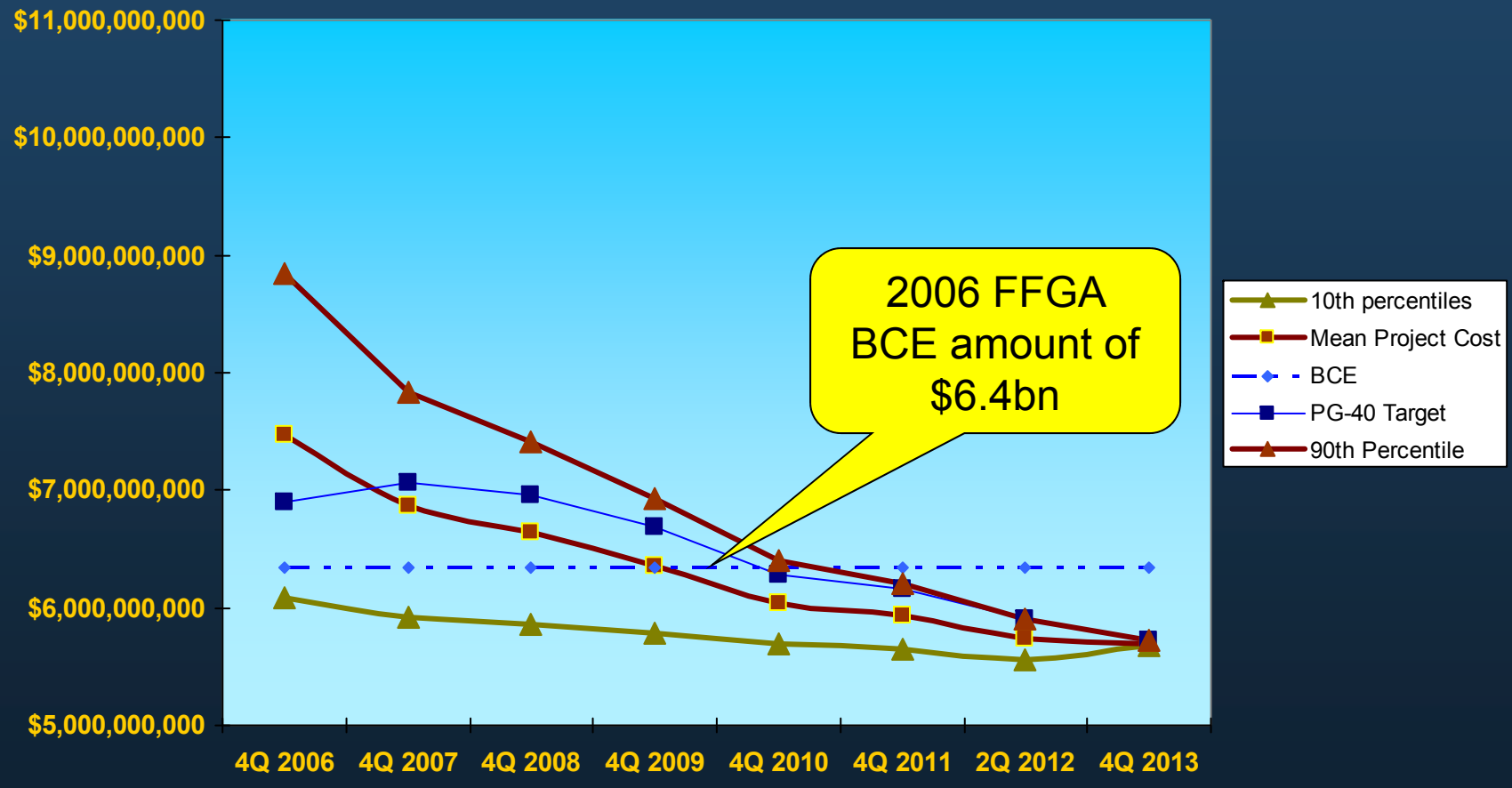
NYCMTA ESA 2006 Baseline
Project Risk Forecast versus Actual



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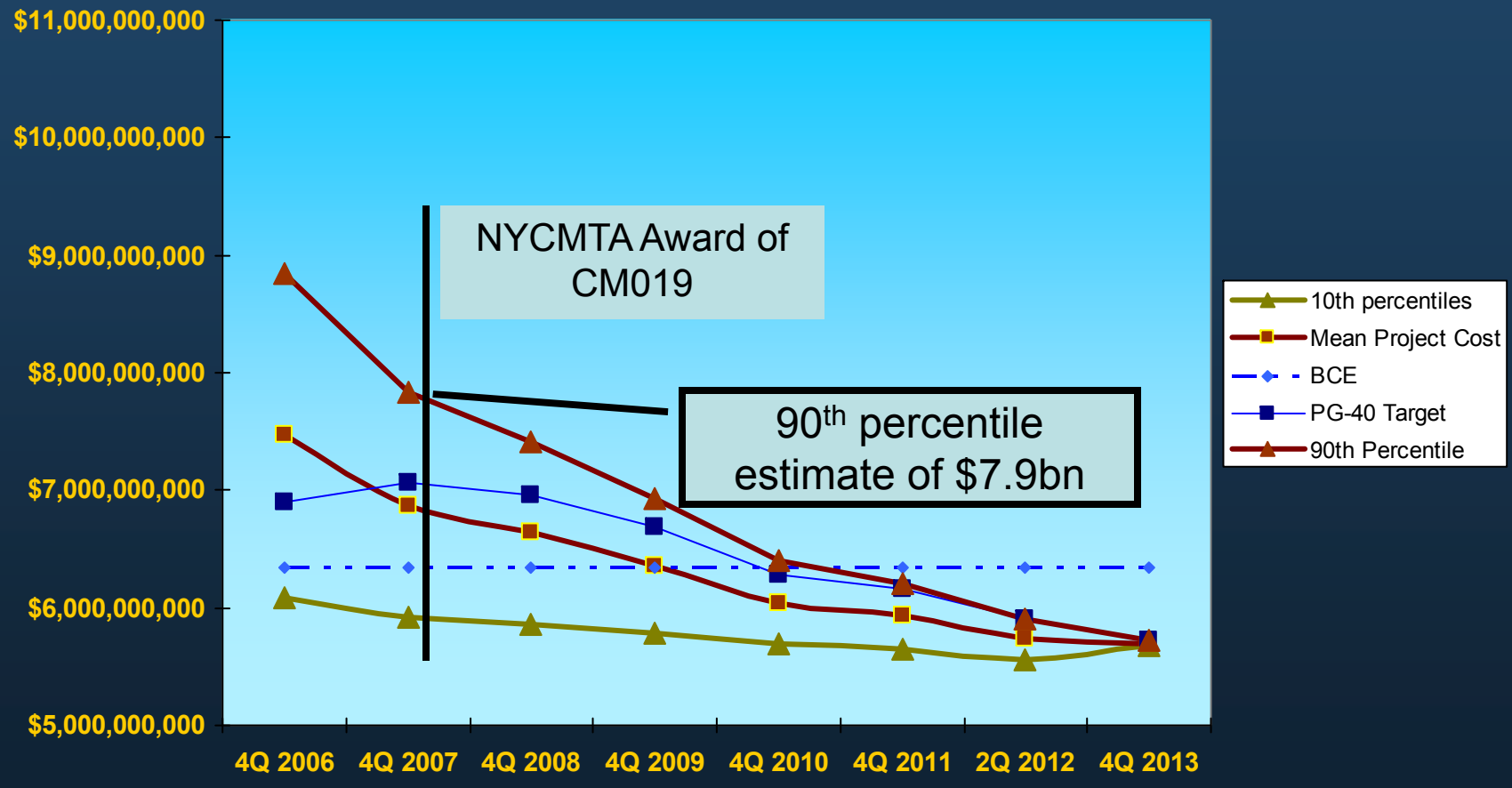

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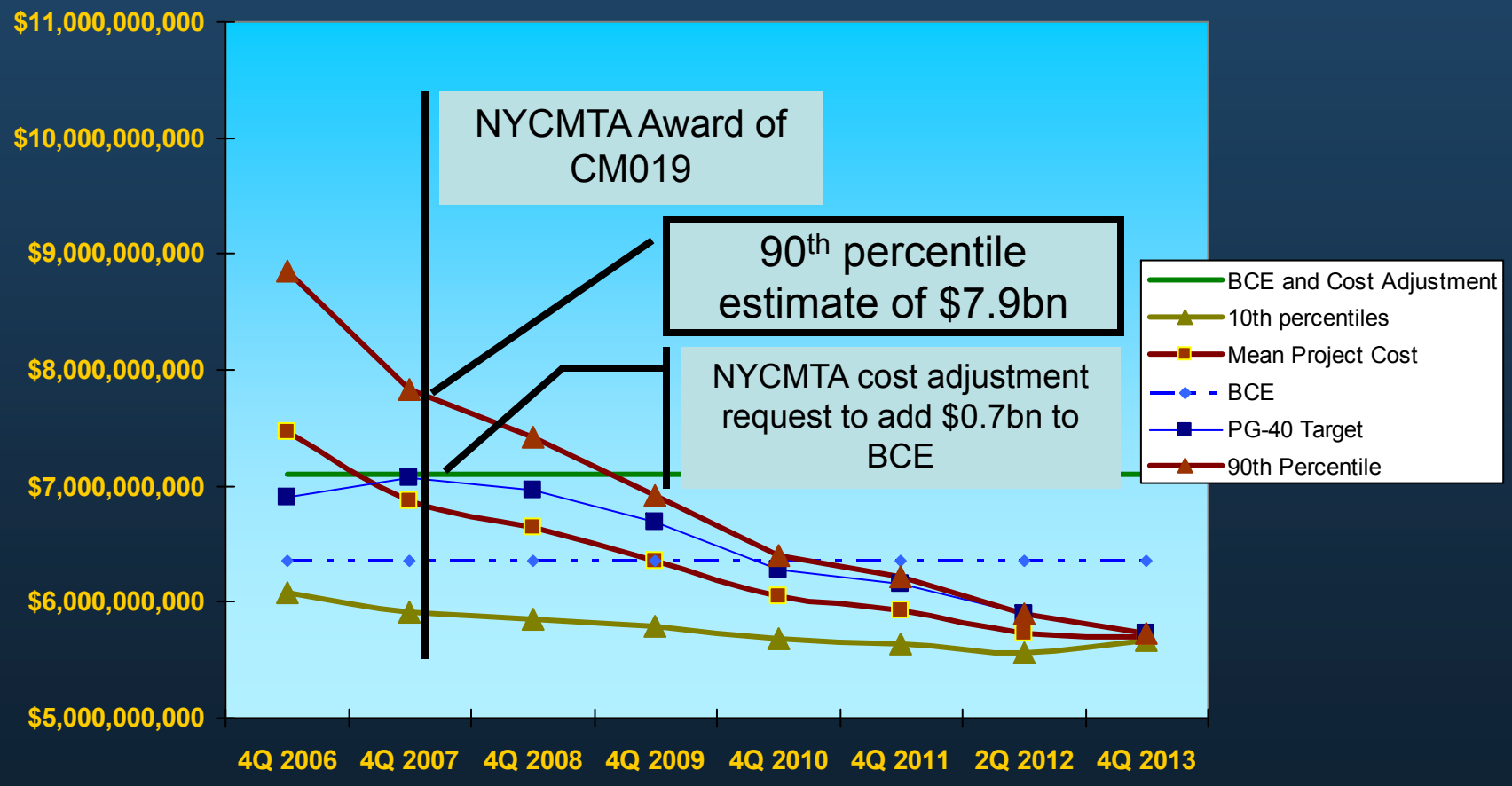

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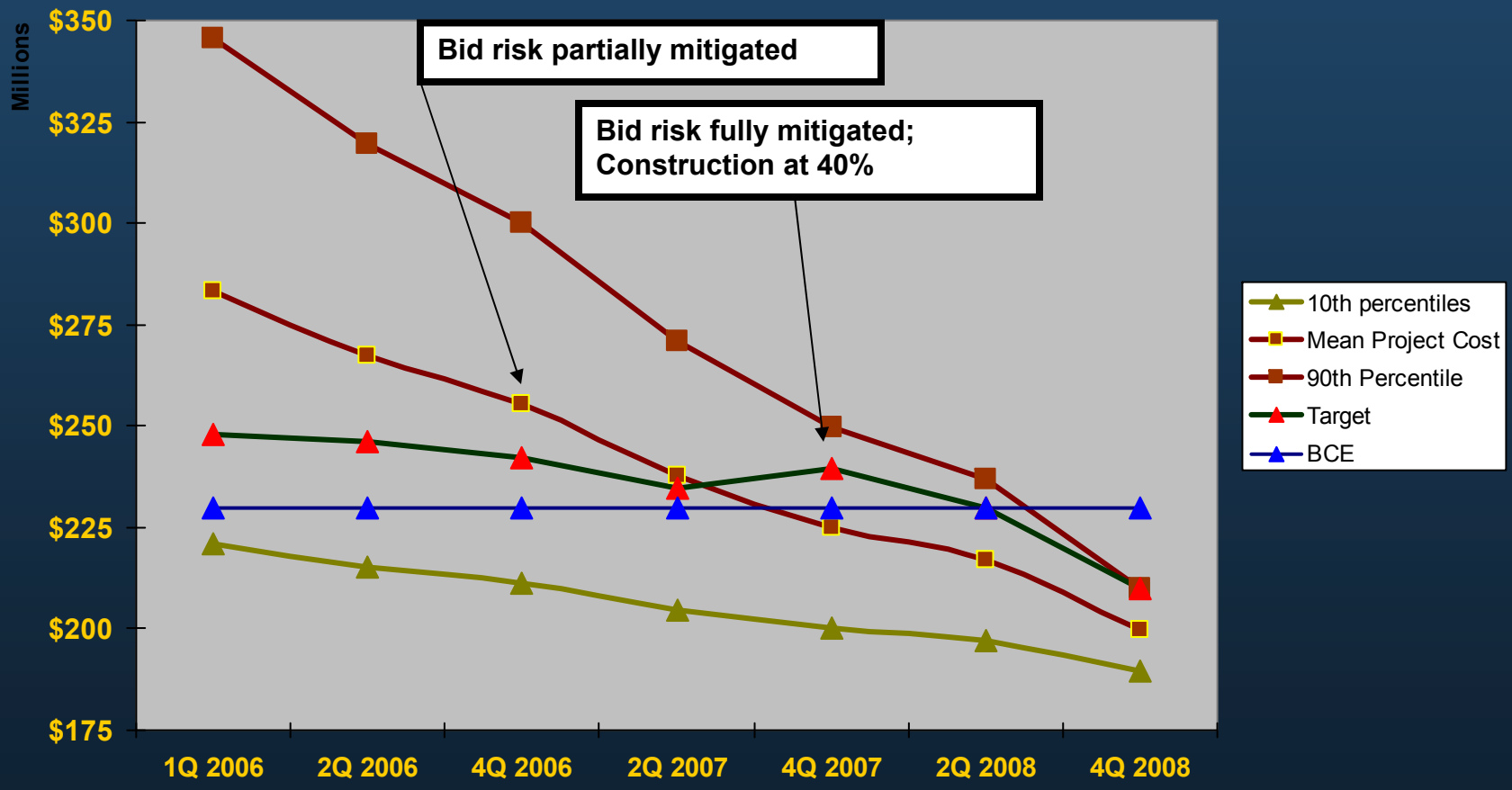
Norfolk VA (HRT) Risk forecast versus Actual

June 22, 2006 Baseline



Threshold Probabilities versus Project Phase

HRT "Triggered" Mitigation Timeframe:*

- Geotechnical and Utility work occurs over the period of 2Q 2007 thru 2Q 2008.
  - Estimate 3 periods where triggered requirements are for $5mm each
- Bid risk peaks in the 4Q 2007 timeframe
  - This will hit in 1 time period where triggered requirements are estimated at 50% of the $21mm, or $10mm.

* Based upon 2006 HRT workshop.

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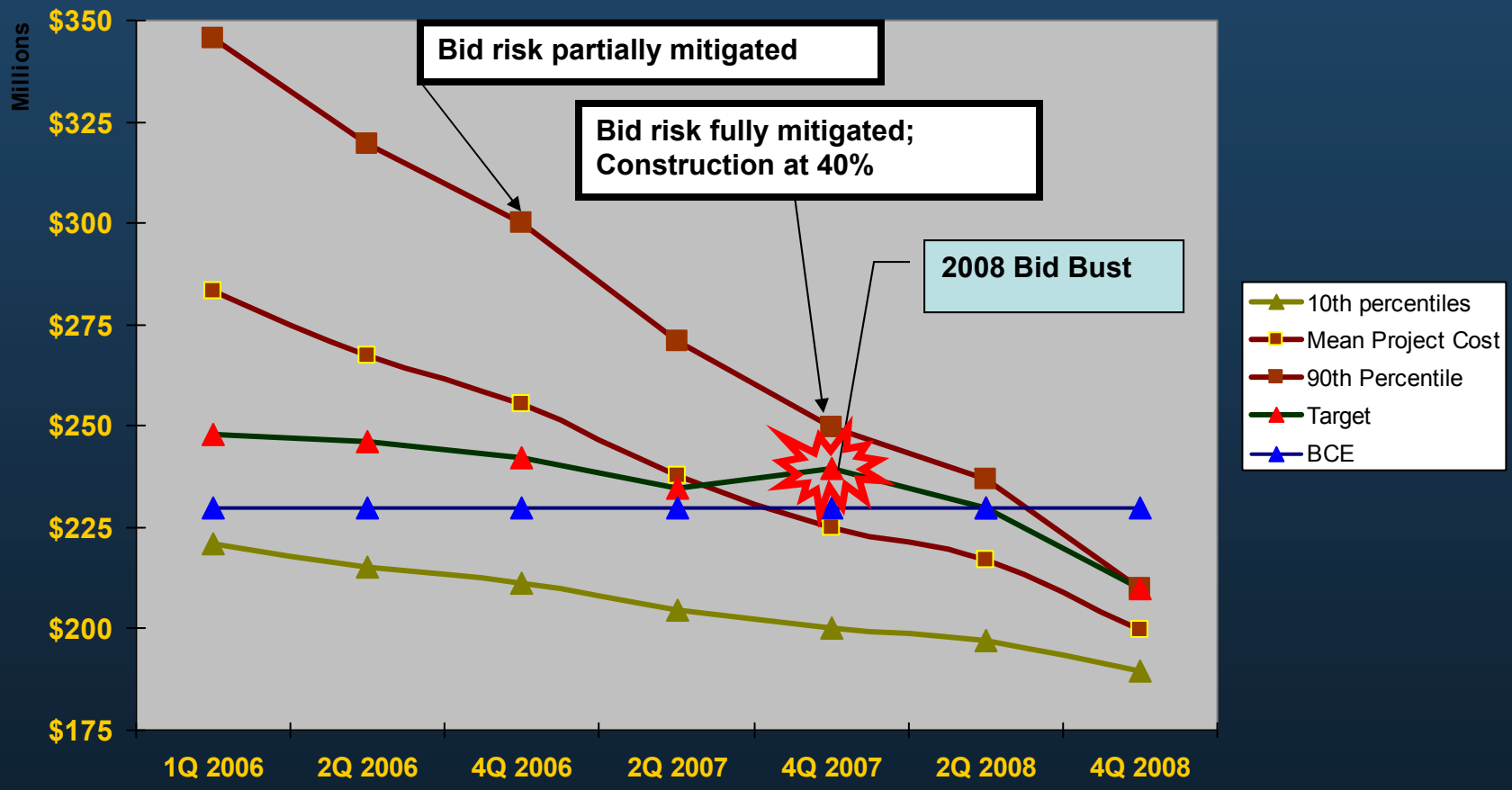
Norfolk VA (HRT) Risk forecast versus Actual

June 22, 2006 Baseline



PAAC North Shore Case Study
Forecast versus Actual

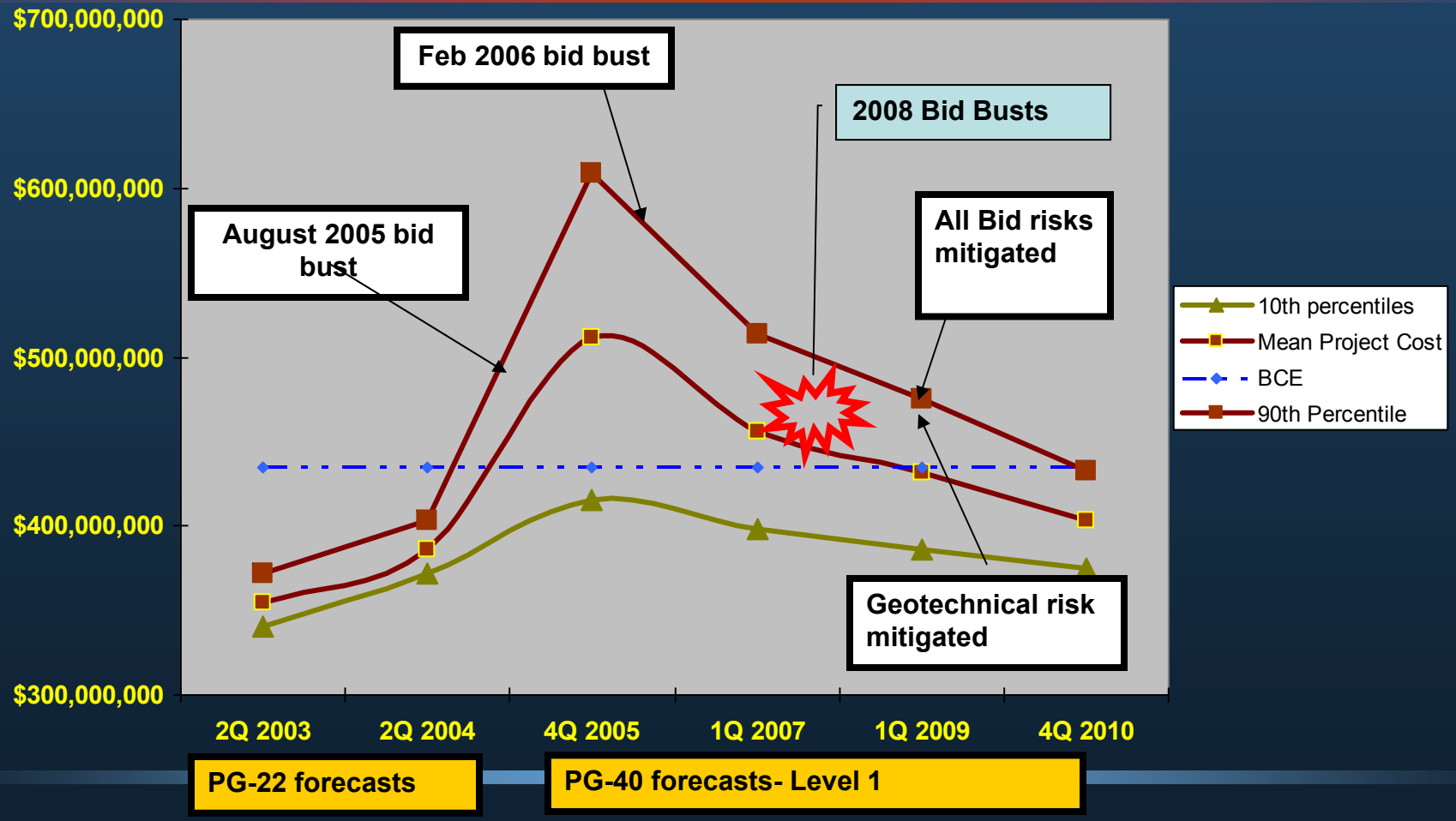
Grantee BCE vs. Thresholds

- The grantee had proposed $428mm (YOE)
- Settled at $435mm(YOE)
- Program milestones and probabilities were estimated using PG-40 models as follows:
  - Partially Bid (2Q 2006): 18%
  - Fully Bid (1Q 2007): 27%
  - 20% Construction* (1Q 2009): 46%
  - Start Up Phase** (4Q 2010): 85%

*Inclusive of Geotechnical and Utility risk ** roughly 90% complete

Note: Using April 17, 2006 model

Pittsburgh Northshore Connector Project Risk versus Time



Threshold Probabilities versus Project Phase

PAAC "Triggered" Mitigation Timeframe:*

- Geotechnical and Utility work occurs over the period of 2Q 2007 thru 2Q 2008.
  - Estimate 3 periods where triggered requirements are for $5mm each
- Bid risk peaks in the 4Q 2007 timeframe
  - This will hit in 1 time period where triggered requirements are estimated at 50% of the $21mm, or $10mm.

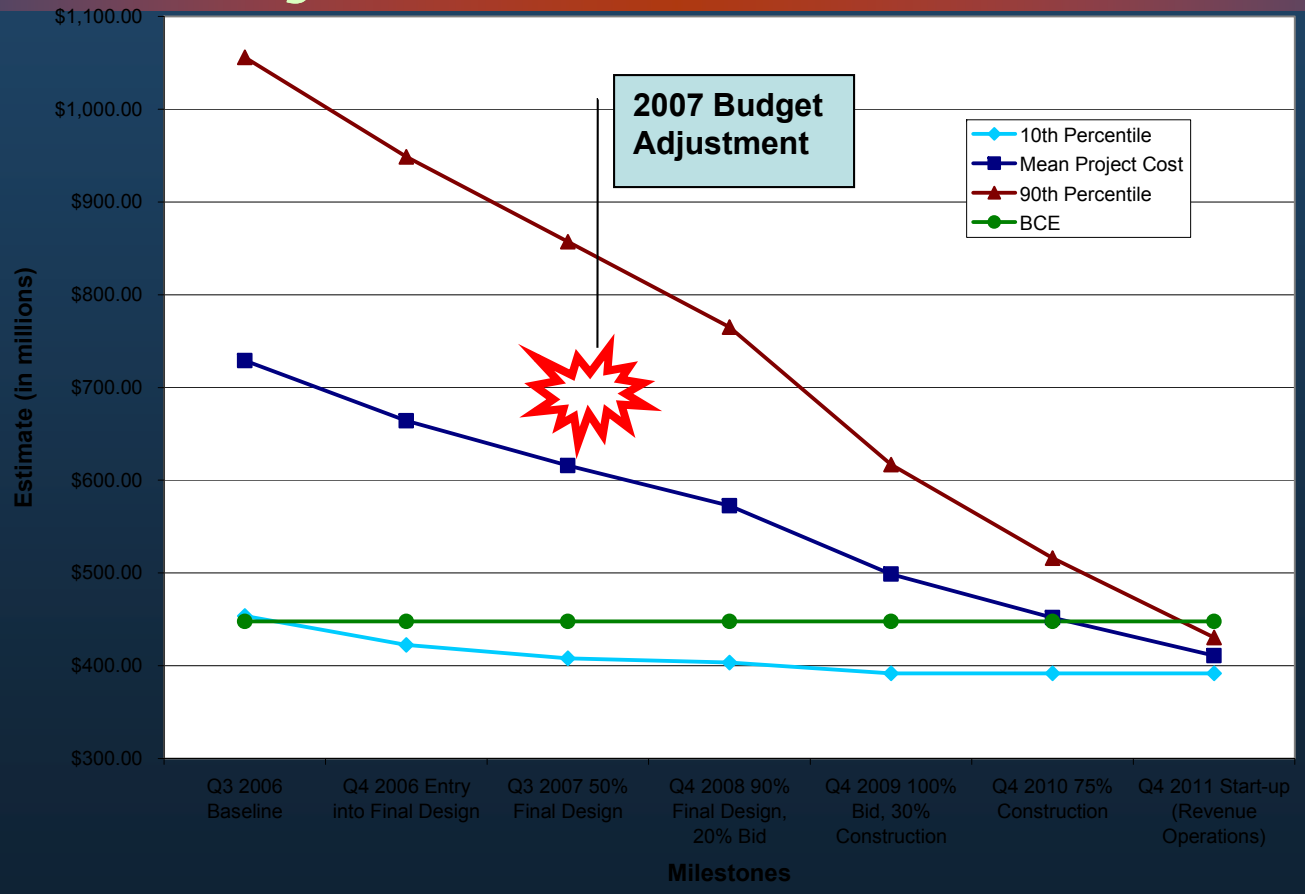
* Based upon May 18, 2006 PAAC workshop.

Threshold Probabilities versus Project Phase

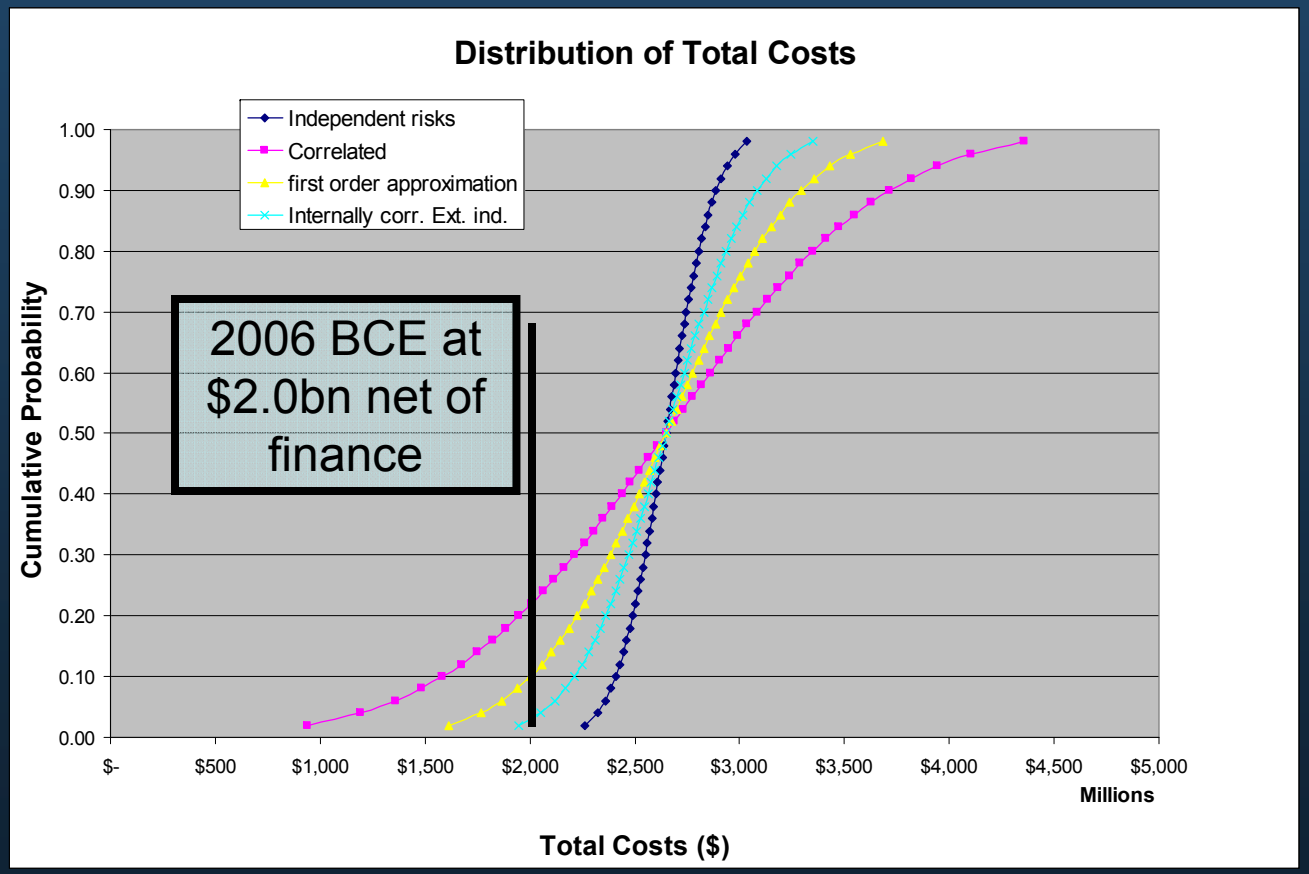
PAAC "Triggered" Mitigation Timeframe:*

- 2Q 2007 thru 3Q 2007.
  - Triggered requirements are for $5mm each Q
- 4Q 2007 thru 1Q 2008 **[Bid risk]**
  - triggered requirements are for $15mm each Qtr.
- 2Q 2008 thru 4Q 2008.
  - Triggered requirements are for $5mm each Q
- * Based upon May 18, 2006 PAAC workshop.

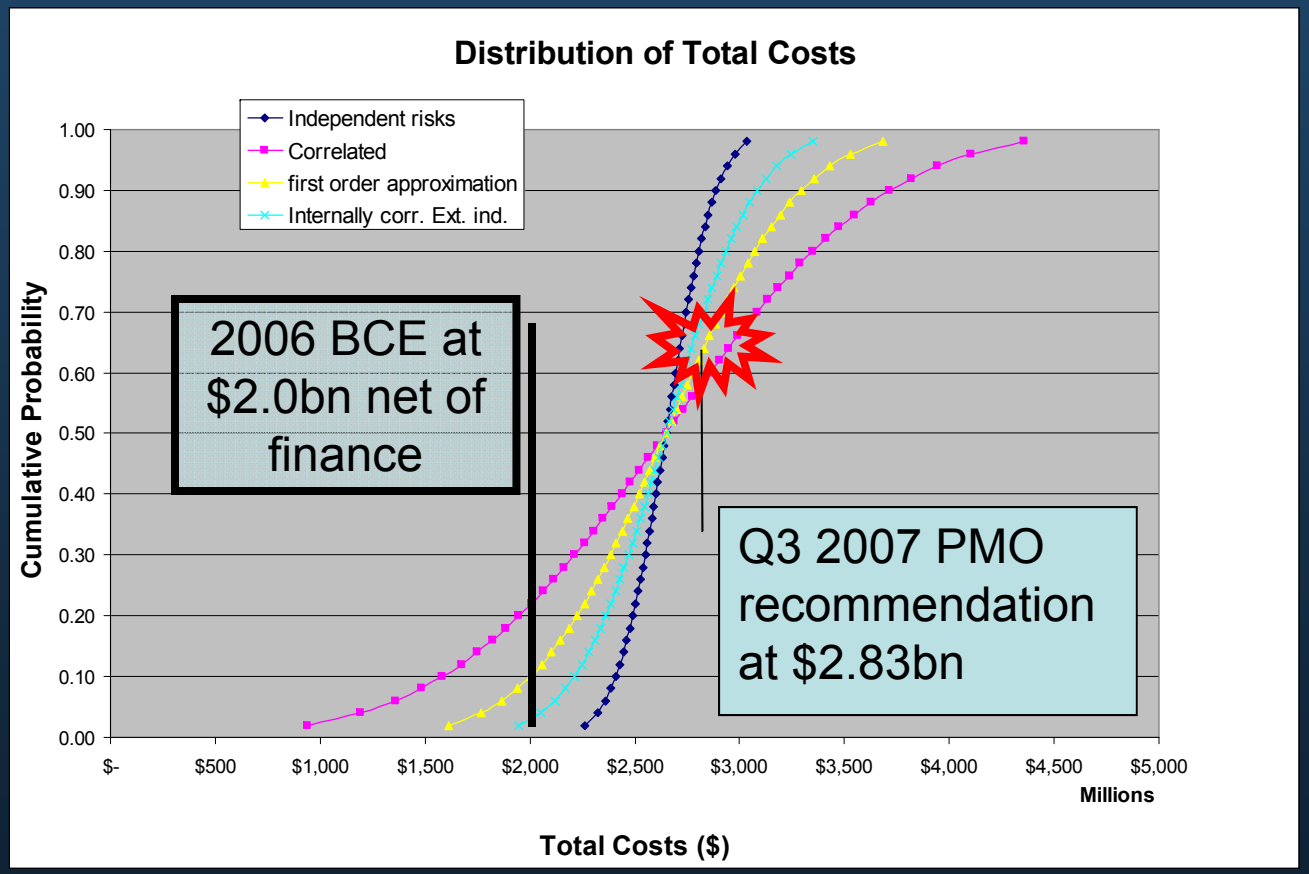
ConnDOT BRT
Project Risk versus Time



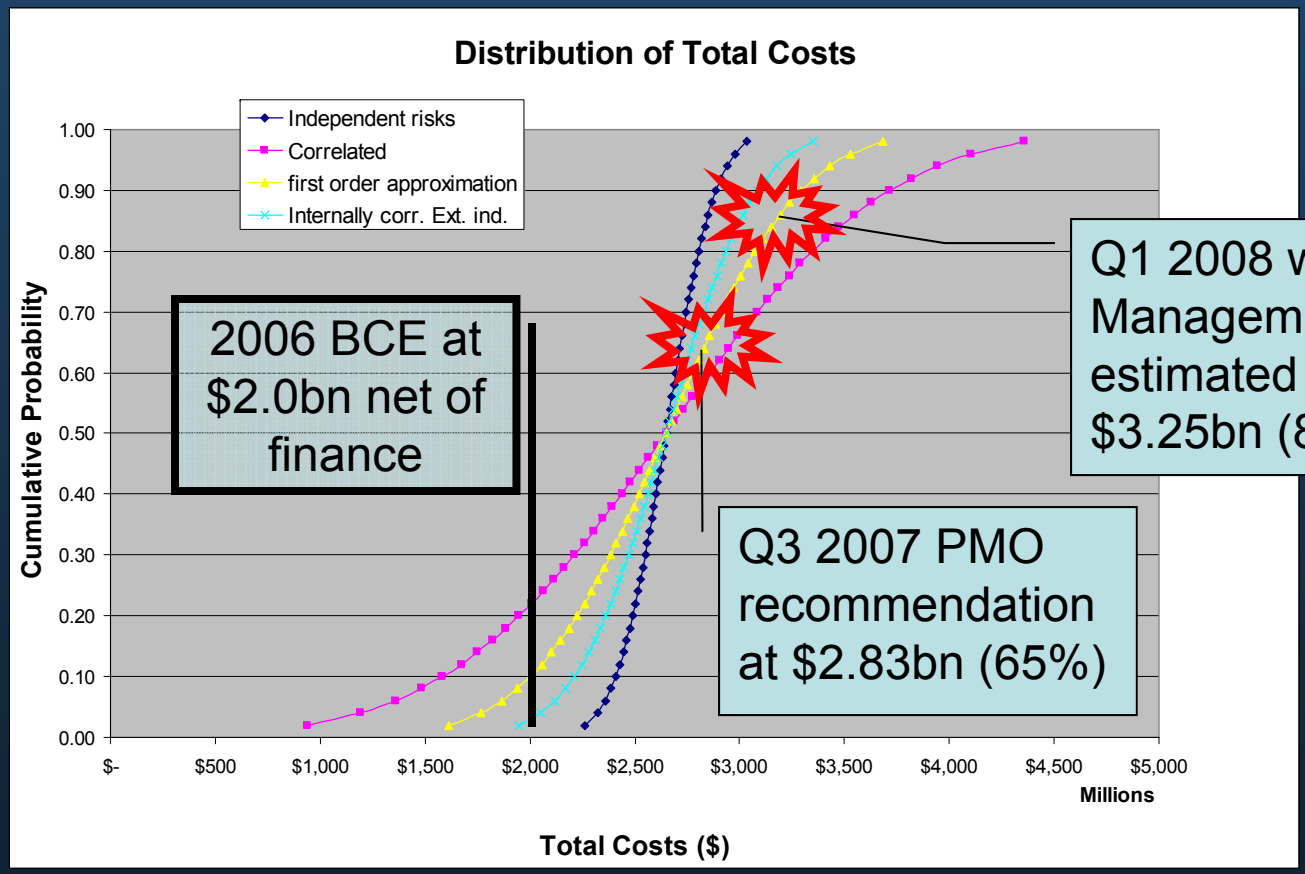
Dulles 2006
Project Risk versus Time



Dulles 2006
Project Risk versus Time



Dulles 2006
Project Risk versus Time



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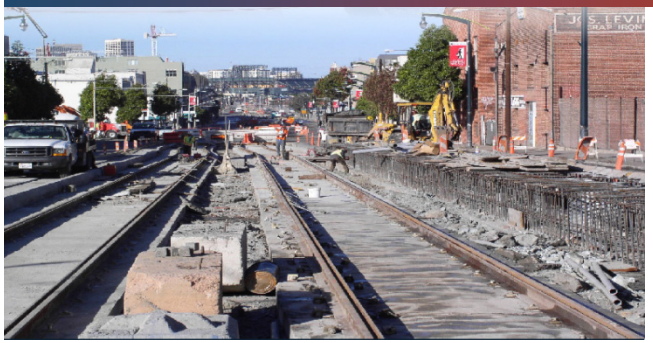
24th FTA Annual Engineers Meeting

June 11-13, 2008

D. Reich
Burns Engineering



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Seattle U Link

- Seattle U Link Project
  - $1.6 billion
  - 3.1 mile twin bored tunnel
  - 2 stations
  - 27 vehicles
  - At mid Final Design
  - FFGA execution expected late summer

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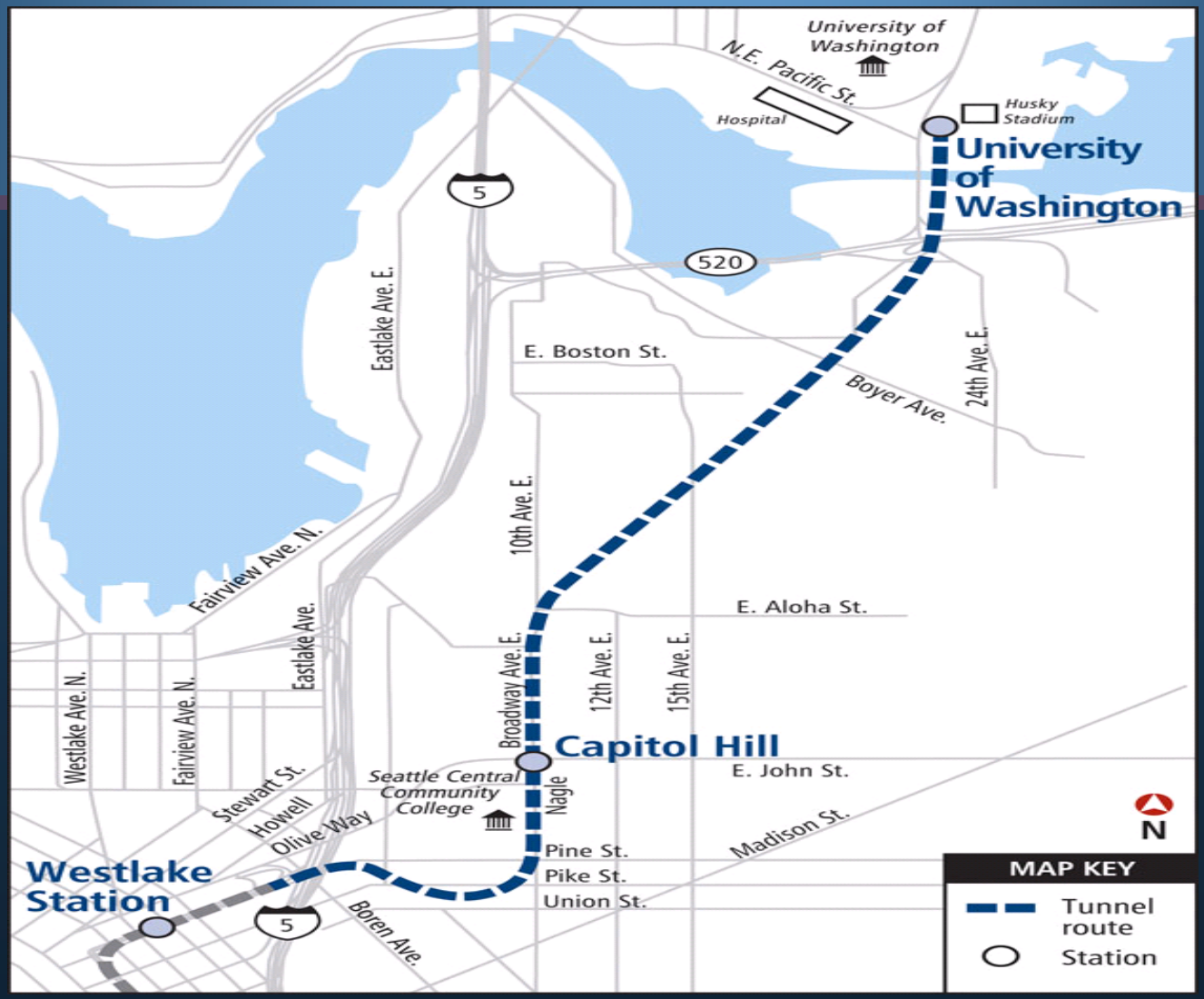

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Risk Products developed for U Link

- PG32 C - Pre Bid Design Scope Review
- PG32 E - Project Delivery Method Review
- PG33B – Definitive Project Cost Estimate Review
- PG34A/PG40 B - Project Schedule Risk products

- The Lesson Learned in this review are:
  - Geotechnical Risks – undefined Geotech “baselines”
  - Market Risks – competing tunnel projects nationally
  - Sensitivity of cost estimate to TBM availability and production rates

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Focus of Seattle Project Evaluation

- Geotechnical Risks
- Level of Design Development
- Contract Packing Strategy
- Project Delivery Method
- Market Conditions – Competitive Analysis
- Contract Indirect Cost Review
- Schedule Achievability
- "Weighted" Contingency Review

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Geotechnical Risks to the estimate

- Glacially derived sediments, as expected along the main tunnel drives, are anticipated to cause increased wear (above normally experienced) on the TBMs. No considerations for such geologic conditions are included in the estimate, which affects production rates and cost.

- Cost estimate based on TBM advance rate and crewing requirements. No Learning Curve or downtime costs identified. TBM availability issues. Mucking costs identified as “plug” number. Muck sites not identified.

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Geotechnical Risks to Project cost

- Soil conditions change abruptly in the main tunnels in at least six locations. No consideration has been given to these changes in geologic conditions and unforeseen problems typically associated with mixed geological materials are not included in the estimate.

- Estimate should have pricing which reflects consideration of varying production rates, increased TBM maintenance costs and durations of downtime, ground conditioning, groundwater inflows, GBR/GIR.

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The need to fully define project elements – Scope Risk

- At the I-5 undercrossing pits, U Link needs to develop detailed prescribed methods, with step by step approach to incrementally removing piles, while fully supporting the resultant face area until CDF structural fill can be fully placed. These methods must be fully determined, specified and depicted in detail before this particular contract is let for bid.
- Details of supporting the existing cylinder piles, as well as the means and methods of removal and support of the soil beyond, need further development.

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ASCE Market Risk assessment

- Market risks to the project are also significant. The potential for Market risks could add as much as $232 million to U-Link base bids for the Geotechnical packages if only 1 bid is received for each of the packages. Receiving 2 bids per contract results in a premium of $138 million, and even if 3 bidders bid on all packages, the premium added is still nearly $60 million

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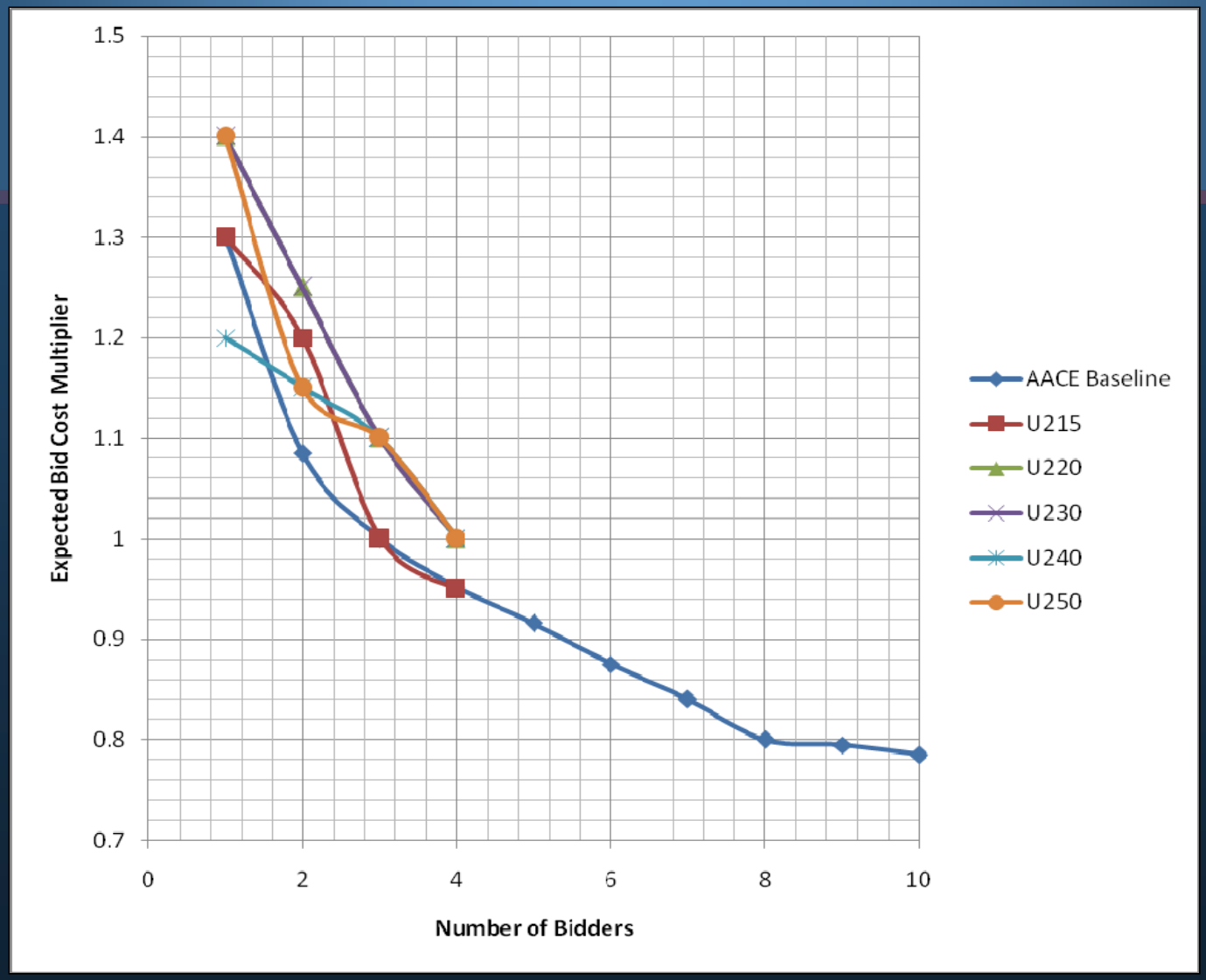

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Geotechnical Baselines

- Of importance is that the U Link project has not yet defined a structure for sharing geotechnical risk with contractors. This is typically accomplished through the development of a contract specific Geotechnical Baseline Report (GBR), which delineates “baselines” of responsibility for dealing with ground conditions expected, as well as eventually encountered in concert with the DSC clause.
- The GBR provides those parameters so that contractors can tender a reasonable bid.

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Typical GBR baselines & Estimating

- The estimated amounts and distribution of different materials on the project
- Description, strength, and permeability of the ground mass as a whole
- Quality of rock mass and characteristics of discontinuities, including roughness, infilling materials and alteration
- Groundwater levels and groundwater conditions anticipated, including items such as inflows, estimated pumping volumes and rates, and anticipated groundwater chemistry
- The anticipated behavior of the ground, and the impact of groundwater, with regard to applicable methods of excavation and installation of ground support
- Construction impacts on adjacent facilities
- Potential or known faults, shears, fault zones, and shear zones, and
- Other geotechnical or known man-made sources of potential difficulty or hazard that could impact the construction process, such as boulders, abandoned piles, buried utilities, buried debris and other obstructions, high or low top of bedrock, mixed face conditions, geologic contacts, gas, and contaminated ground and groundwater.

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GBR and Differing Site Conditions clause

- The function of the DSC clause is two-fold.
- First, it relieves the contractor of assuming the risk of encountering conditions differing materially from those indicated in GBR and Contract documents.
- Second, it provides a remedy under the construction contract to handle the matter as an item of contract administration. The ease of administering the DSC clause during construction depends on how well the anticipated conditions are defined in a GBR
- The goal of the GBR is to translate the results of the geotechnical investigations into clear descriptions of anticipated subsurface conditions upon which bidders can rely. The GBR also provides the Owner with the opportunity to allocate risks associated with these conditions.

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The Lesson Learned is:

1. Market Conditions risk is significant for tunnel projects

   North American tunnel demand is high – 18 to 20 competing tunnel projects nationally

2. GBR needs to be developed to "price" Indirect costs

   Defining "baselines" tells contractor what to include and exclude in his bids, and what is or is not a "change", i.e. the Differing Site Conditions clause.

3. TBM availability and production rates

   Need to estimate tunnel for varying drive rates and TBM downtime/availability/varying geo conditions.